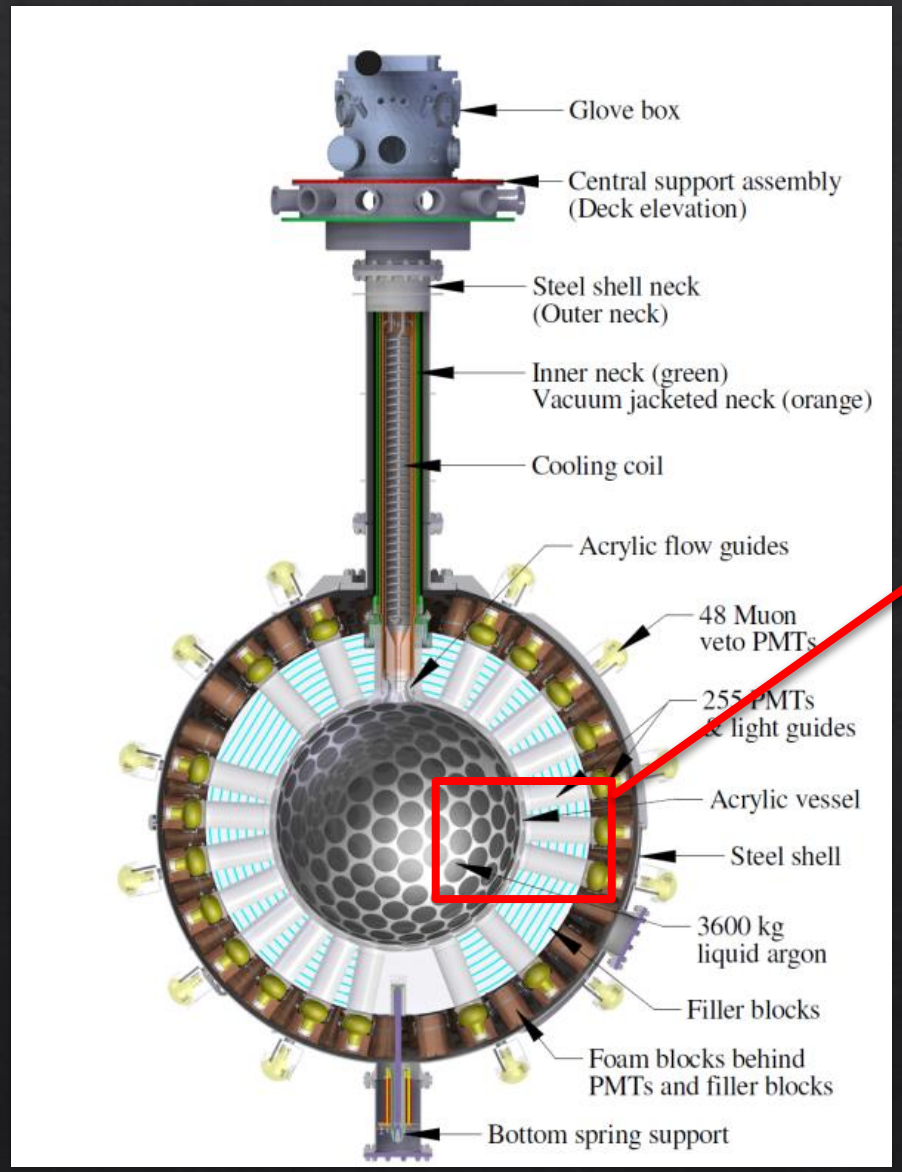
DEAP-3600 Hardware Upgrades and Sanity Checks on High-E EM Band Energy Calibration in RAT v5.16.0

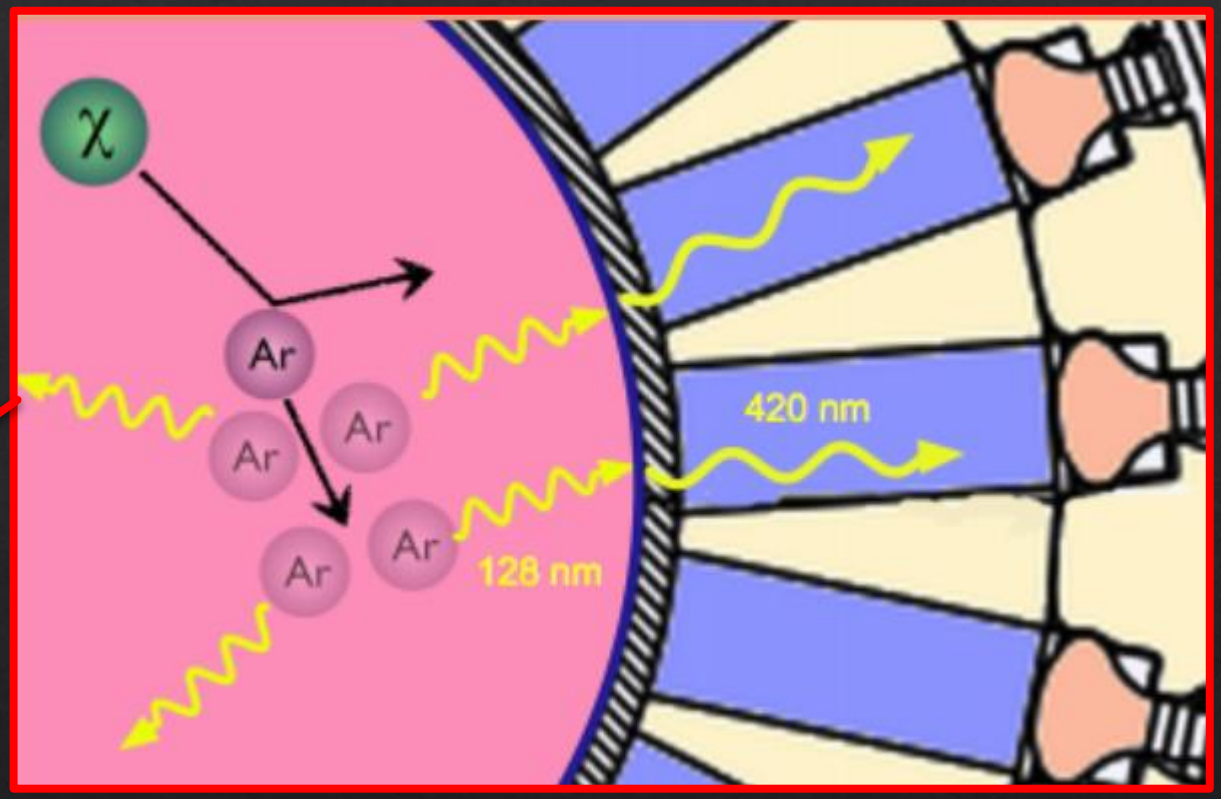
Ayesha Iqbal

Supervisors: Chris Jillings, Pierre Gorel

19-20th August, CASST 2024

Design and Structure

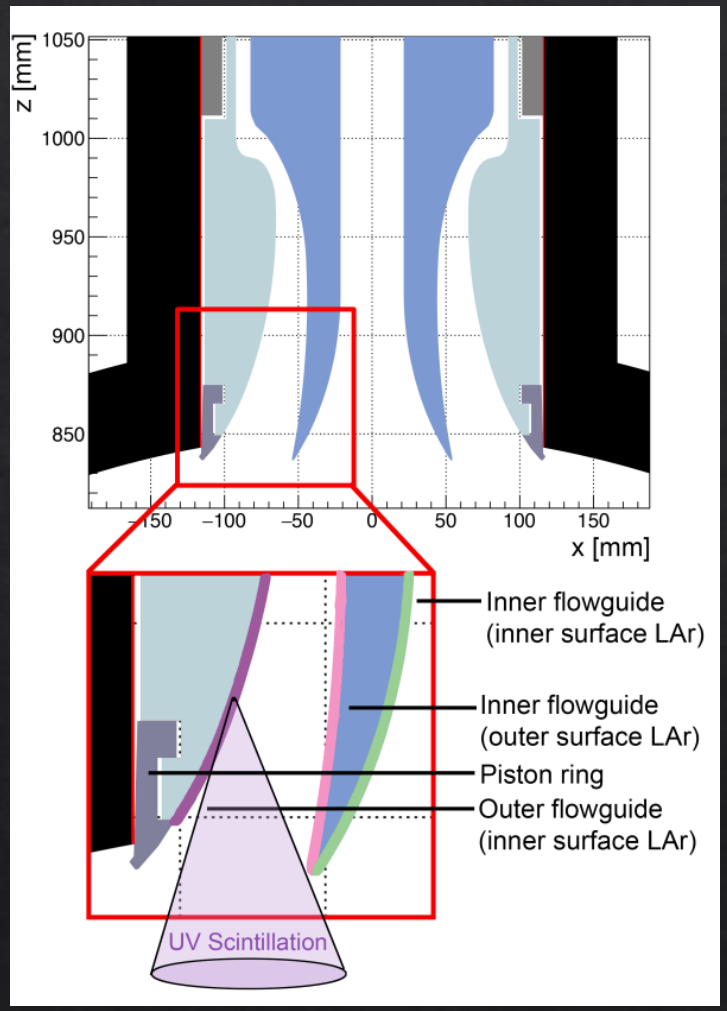


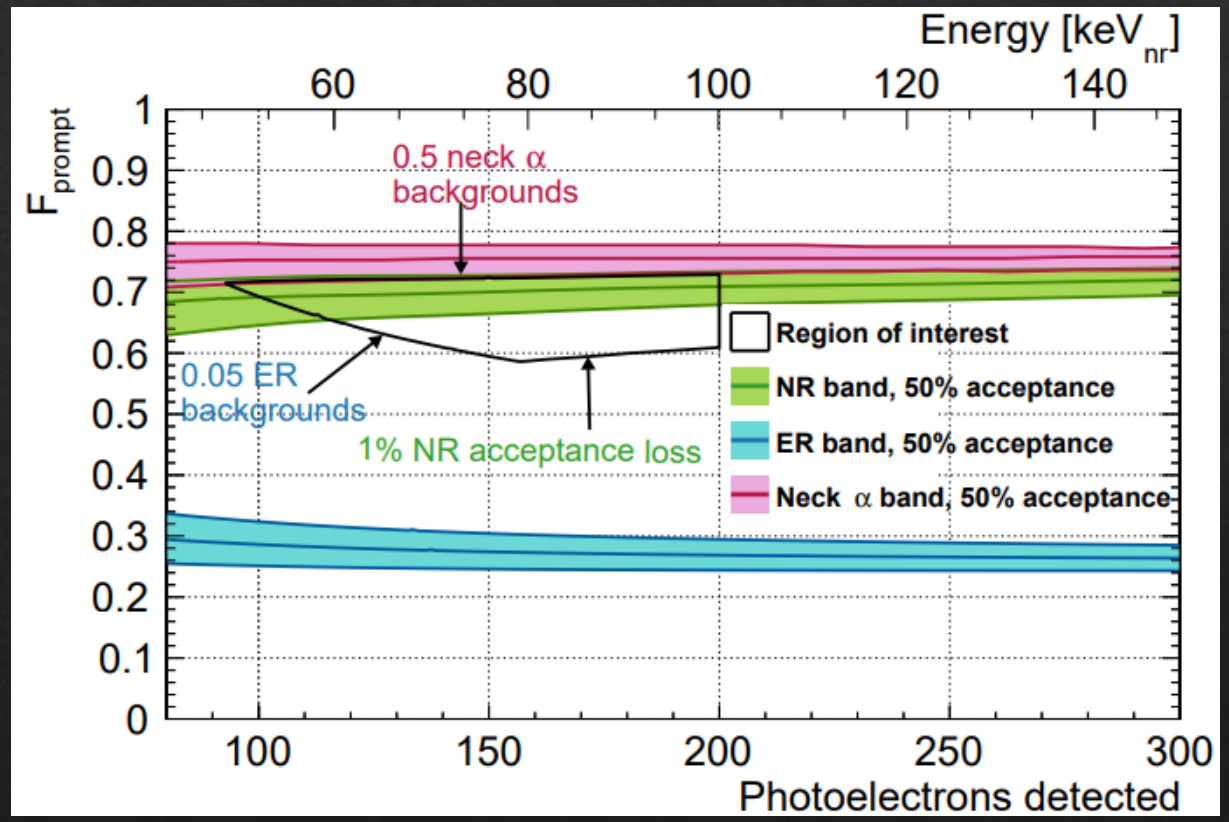


Amaudruz P. et al. 2019. Design and Construction of DEAP-3600 Dark Matter Detector. Astropart. Phys. (108). 1-23.

Why did we need to upgrades?

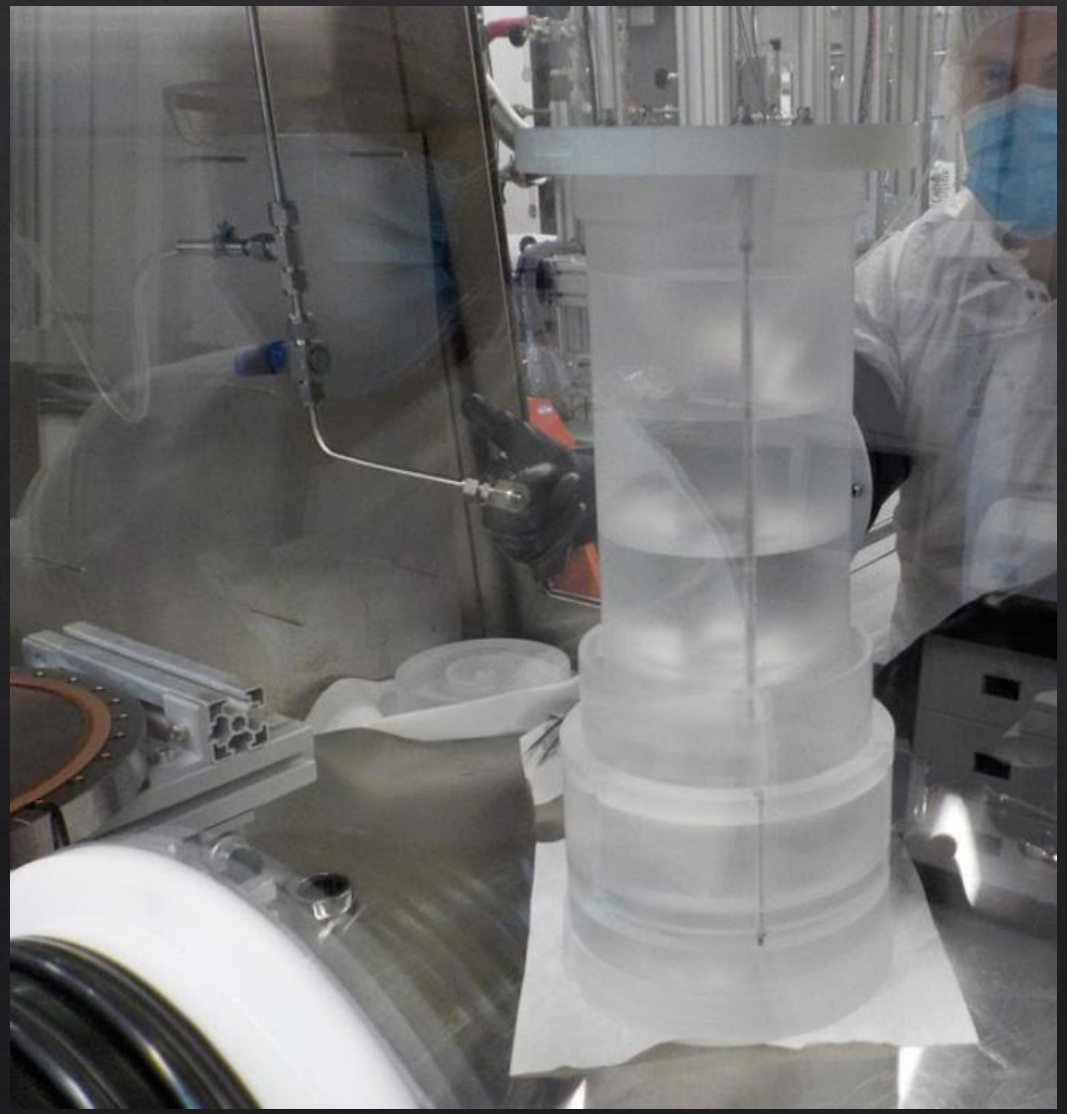
- **Dust** and **alpha-decays** coming from the **Flow Guides in the Acrylic Vessel neck** were observed during previous 3 years of data taking.

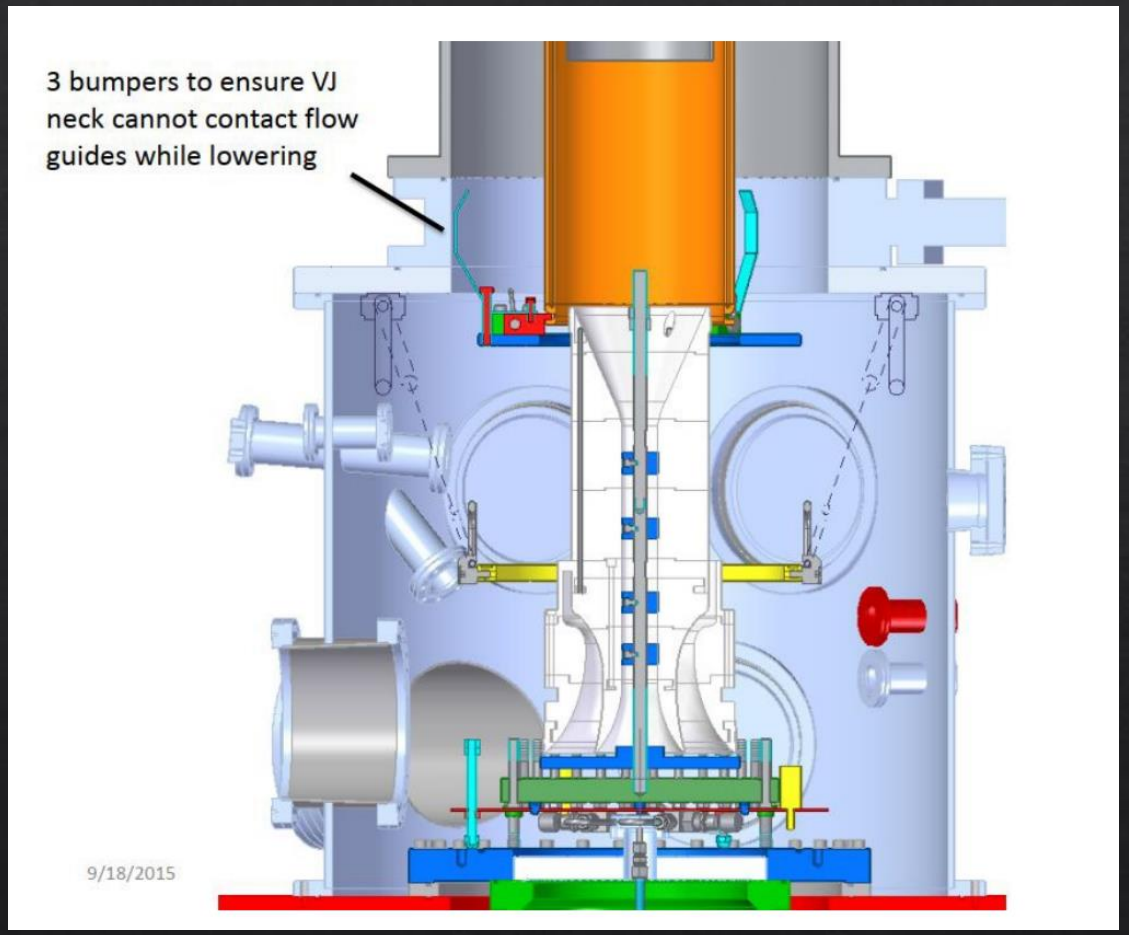




Ajaj. R. et al. 2019. Search for dark Matter with a 231-day exposure of liquid argon using DEAP-3600 at SNOLAB. Phys. Rev. D 100. 022004.

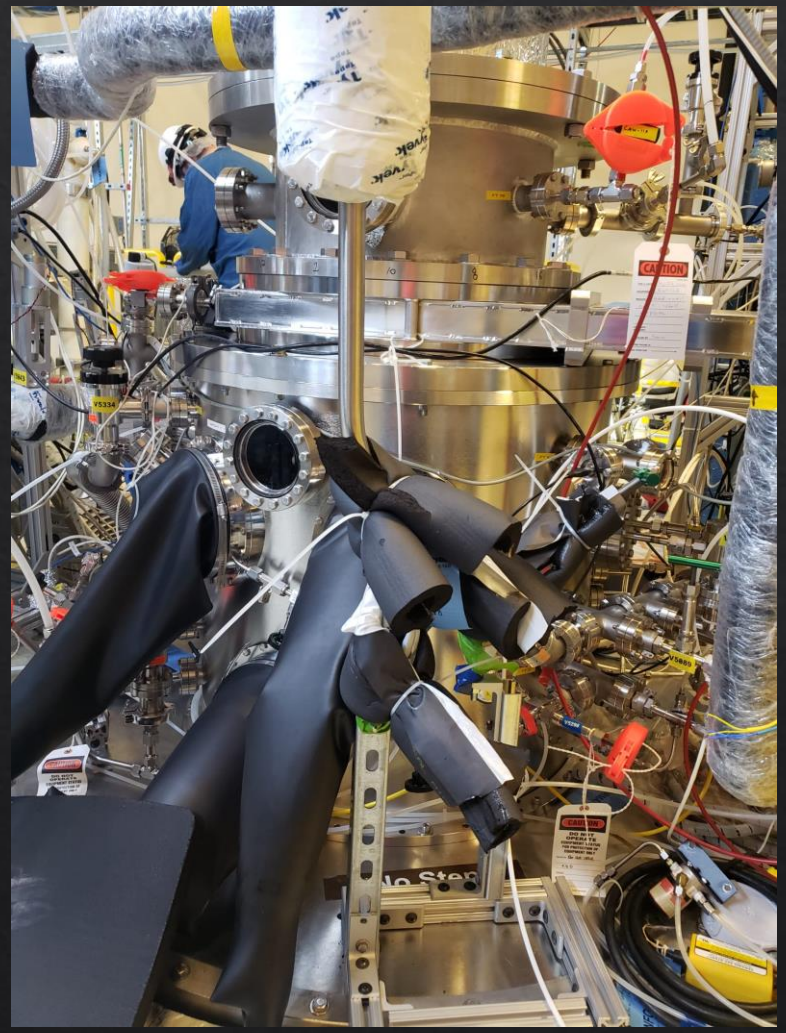
- **Upgraded Flow Guides** coated with **Pyrene** needed to be installed.

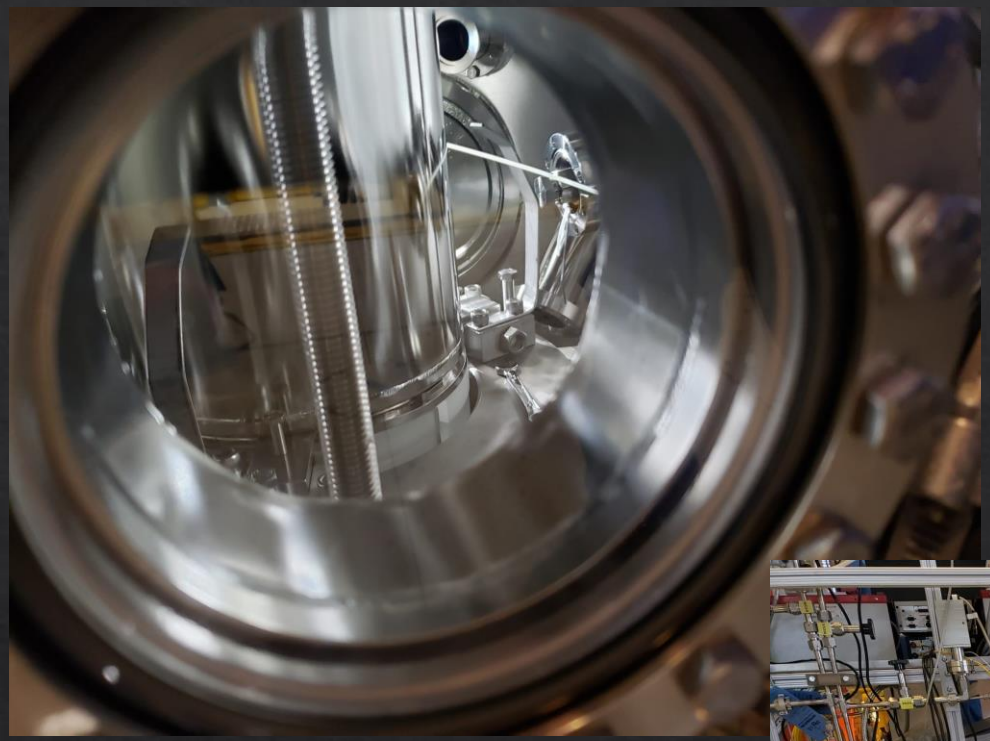


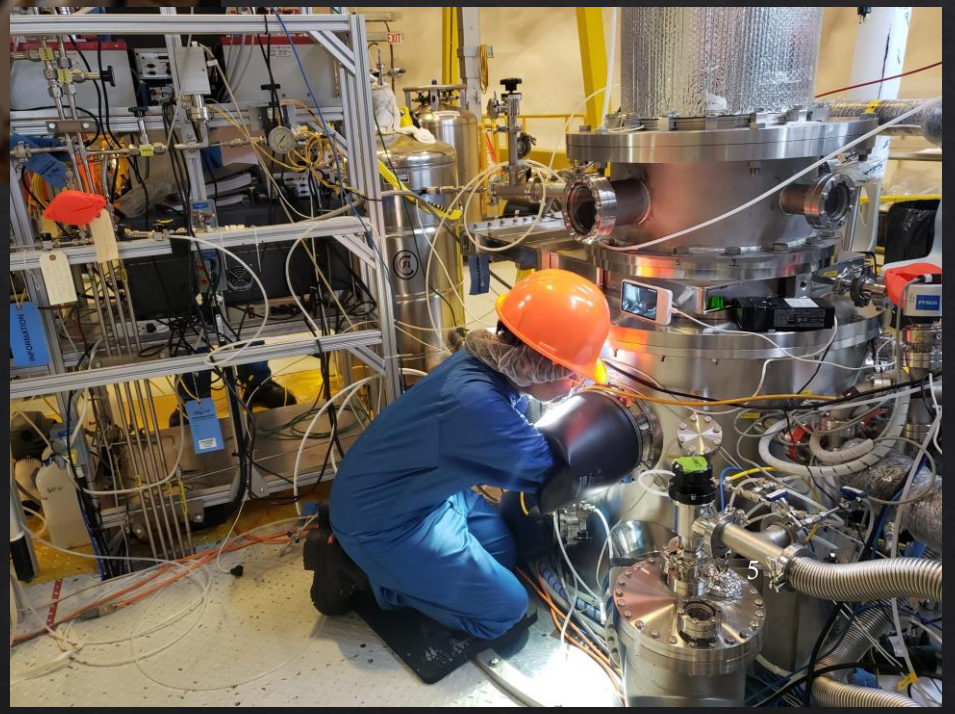


Boulay M., Crampton R., Daugherty S. 2024. DEAP Flowguide and Neck Installation. DEAP-SOP-229 .

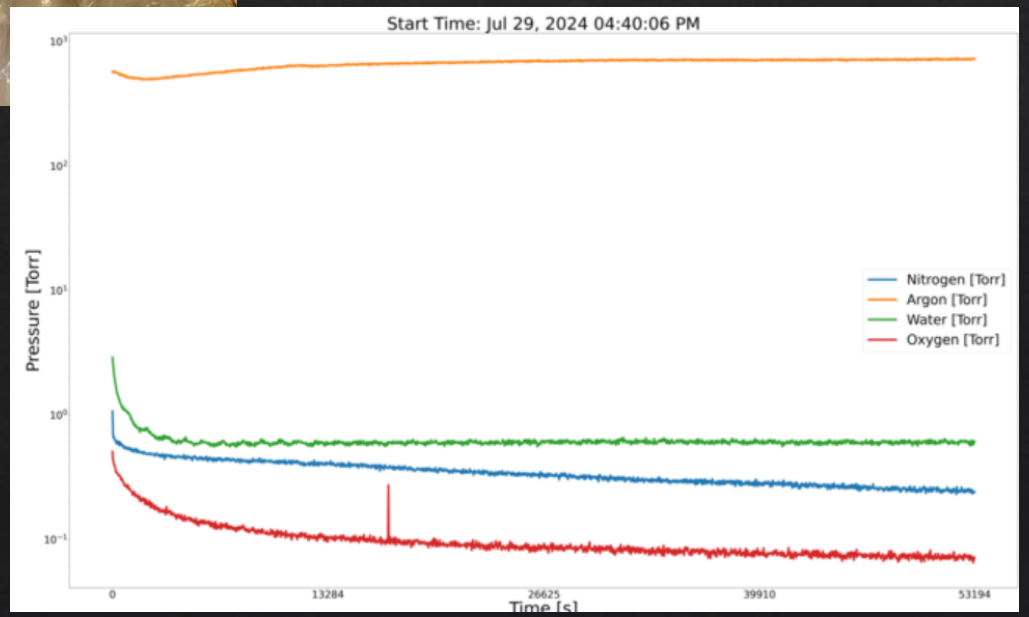
Work in the Glove Box!







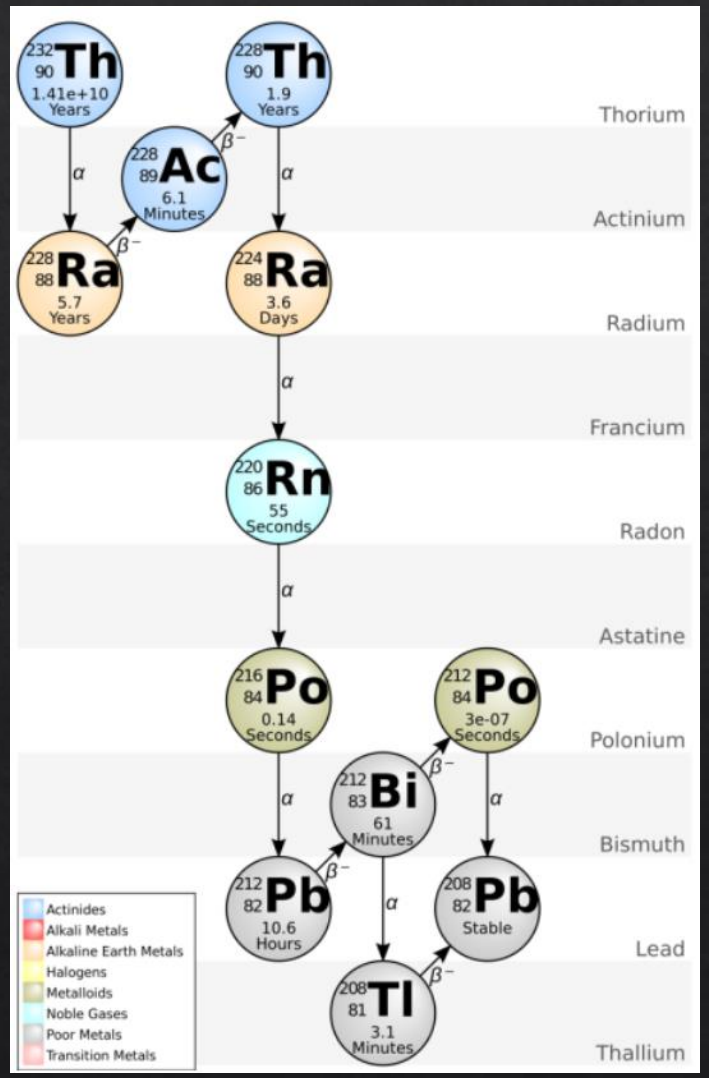

CAUTION


Start Time: Jul 29, 2024 04:40:06 PM
Pressure [Torr]
Time [s]
Nitrogen [Torr]
Argon [Torr]
Water [Torr]
Oxygen [Torr]


26°C 01:23 PM

No Science Without Analysis!

- **Materials used in PMTs or other detector components contains trace amounts of Thorium-232.**



Tl-208 goes through beta-decay and emits gamma-ray of a well-known energy, 2614.5 MeV.

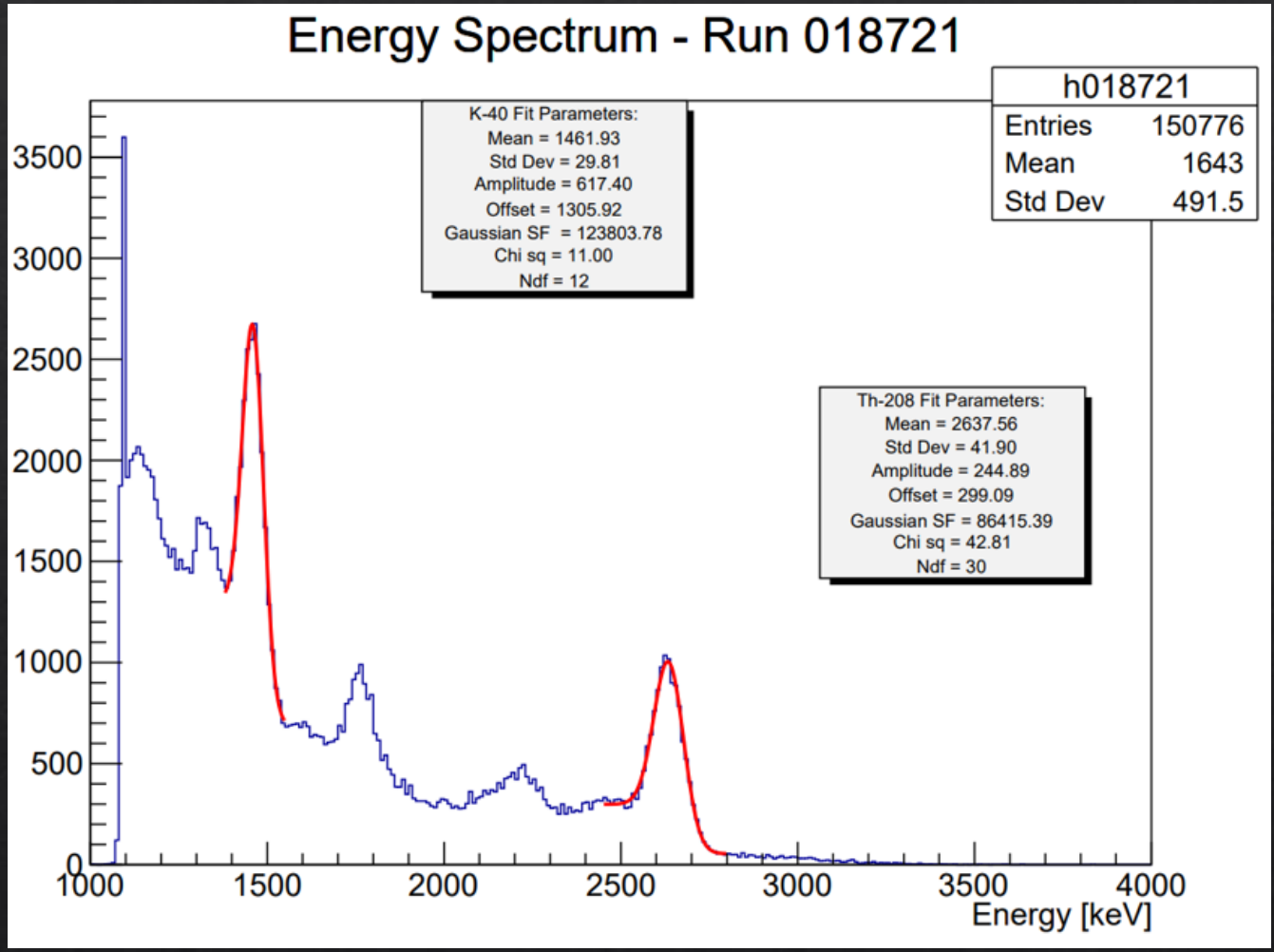
Can be used as a high-energy calibration point for detector energy response.

No Science Without Analysis!

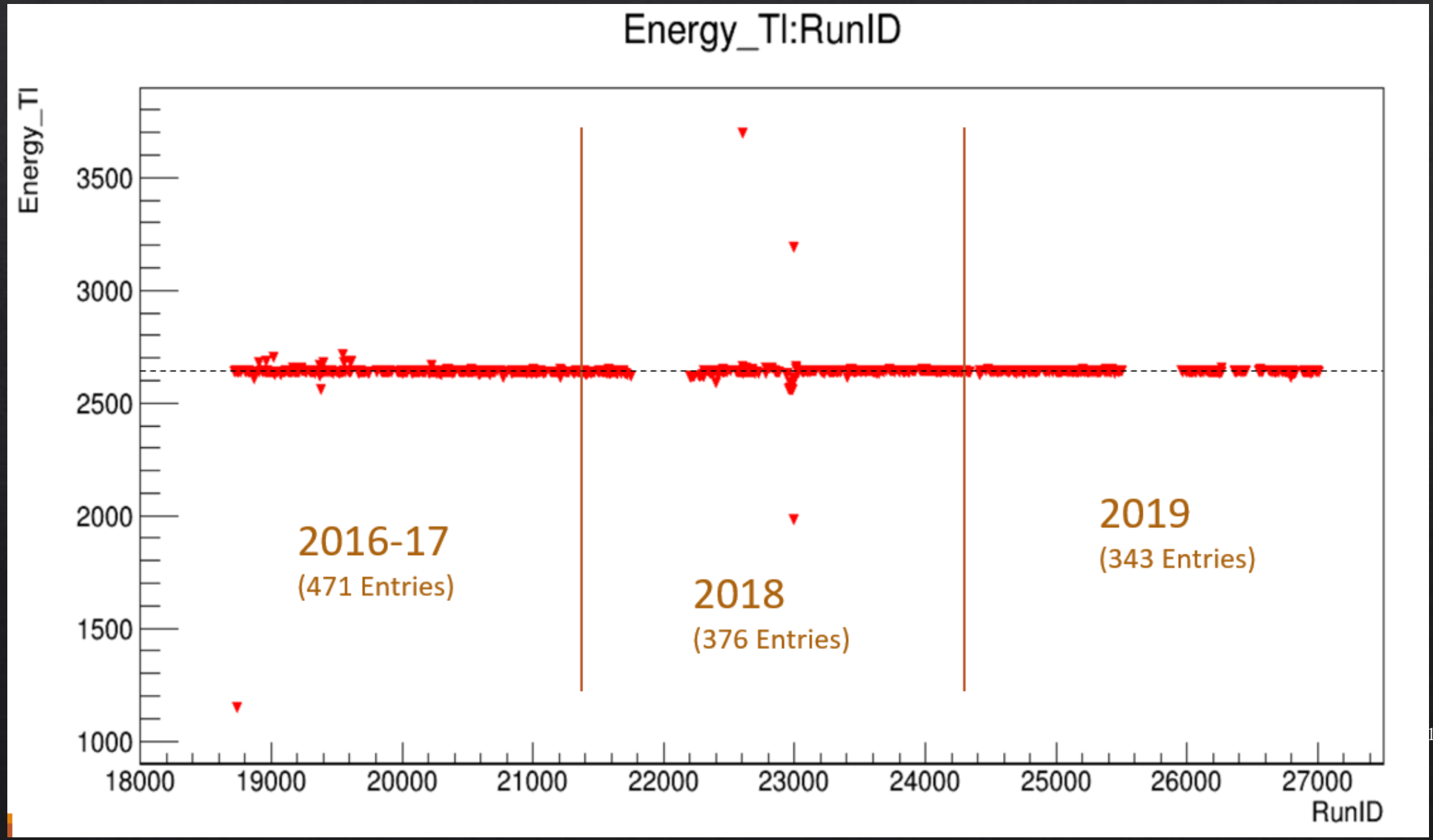
- **K-40 is naturally occurring isotope of Potassium found in PMT glass.**
- **Goes through beta-decay and deposits energy into Liquid Argon at 1460.8 MeV.**
- **Calibration is crucial for distinguishing potential Dark Matter signal and background noise.**

Tl-208 (2.61 MeV) and K-40 (1.46 MeV) Gaussian Peak Fits

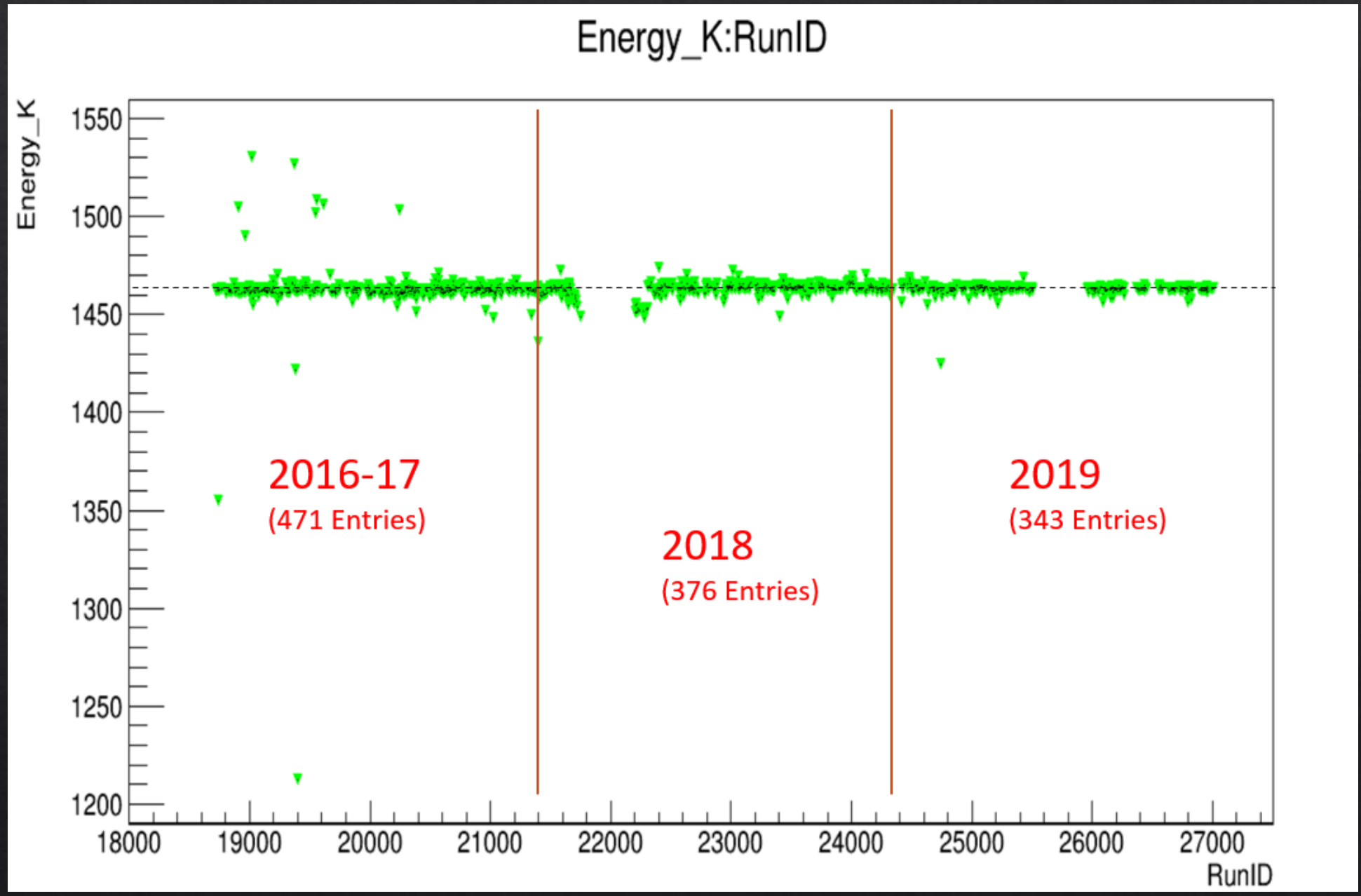
- Processed each run in datasets from 2016-17, 2018 and 2019.
- Energy reconstruction was done using RAT v5.16.0.
- Produced fits into a pdf file so trends can be analyzed.



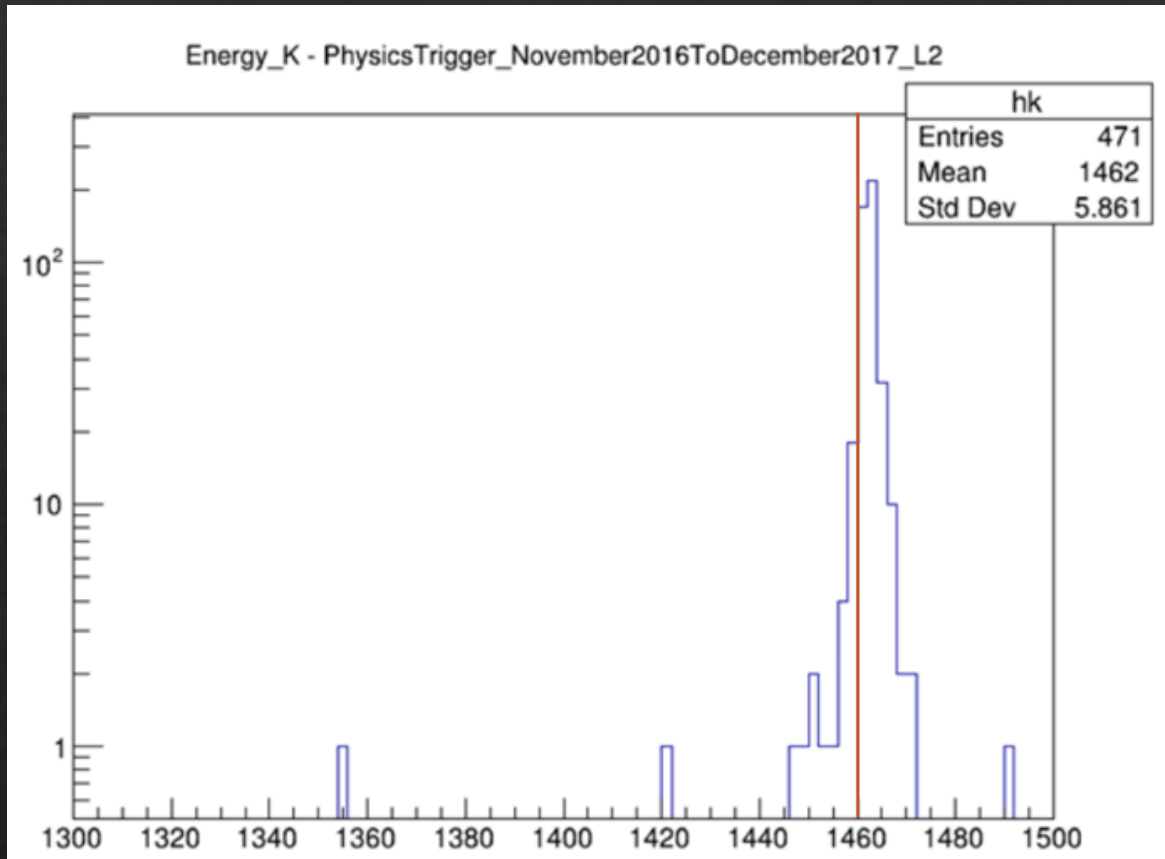
Tl-208 (2.61 MeV) Trend – Energy vs. Run Number for all Years

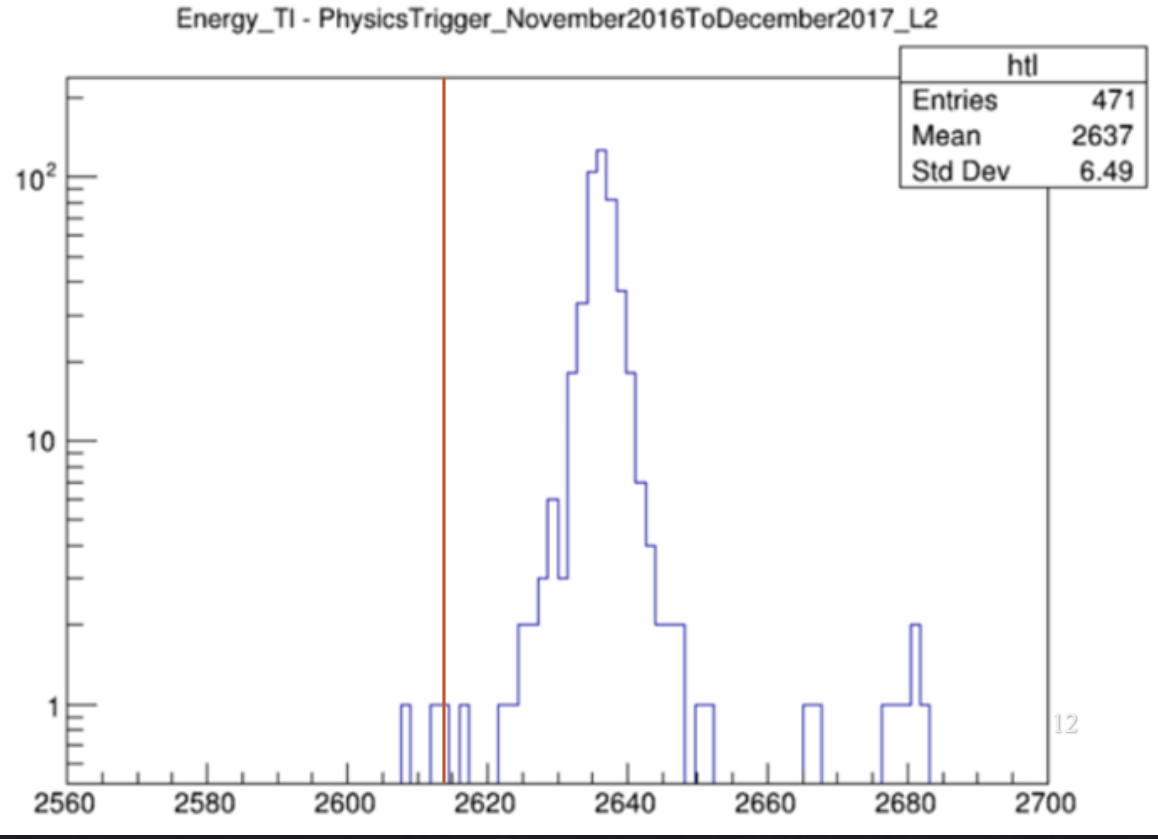


K-40 (1.46 MeV) Trend – Energy vs. Run Number for all Years

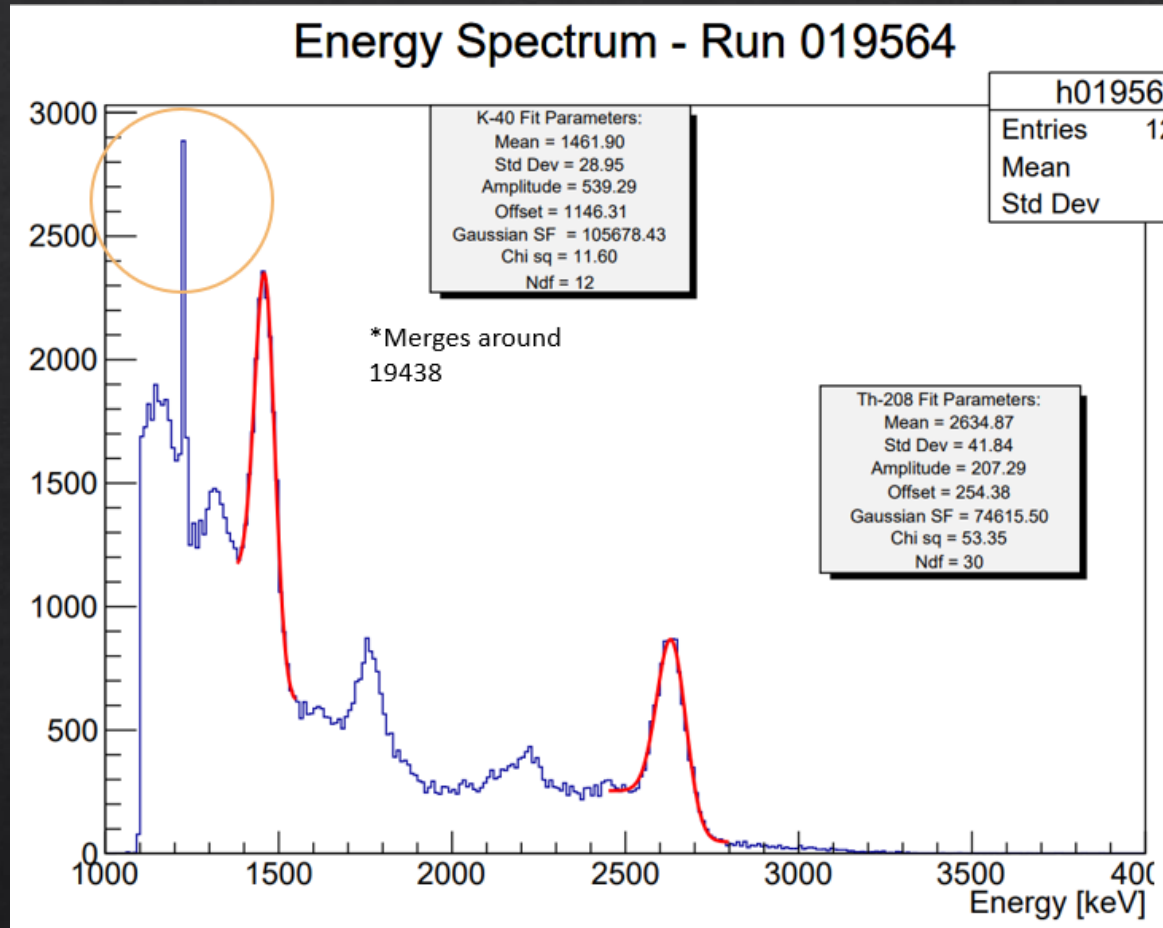


1D Histograms for K-40 & Tl-208 for 2016-17 Data

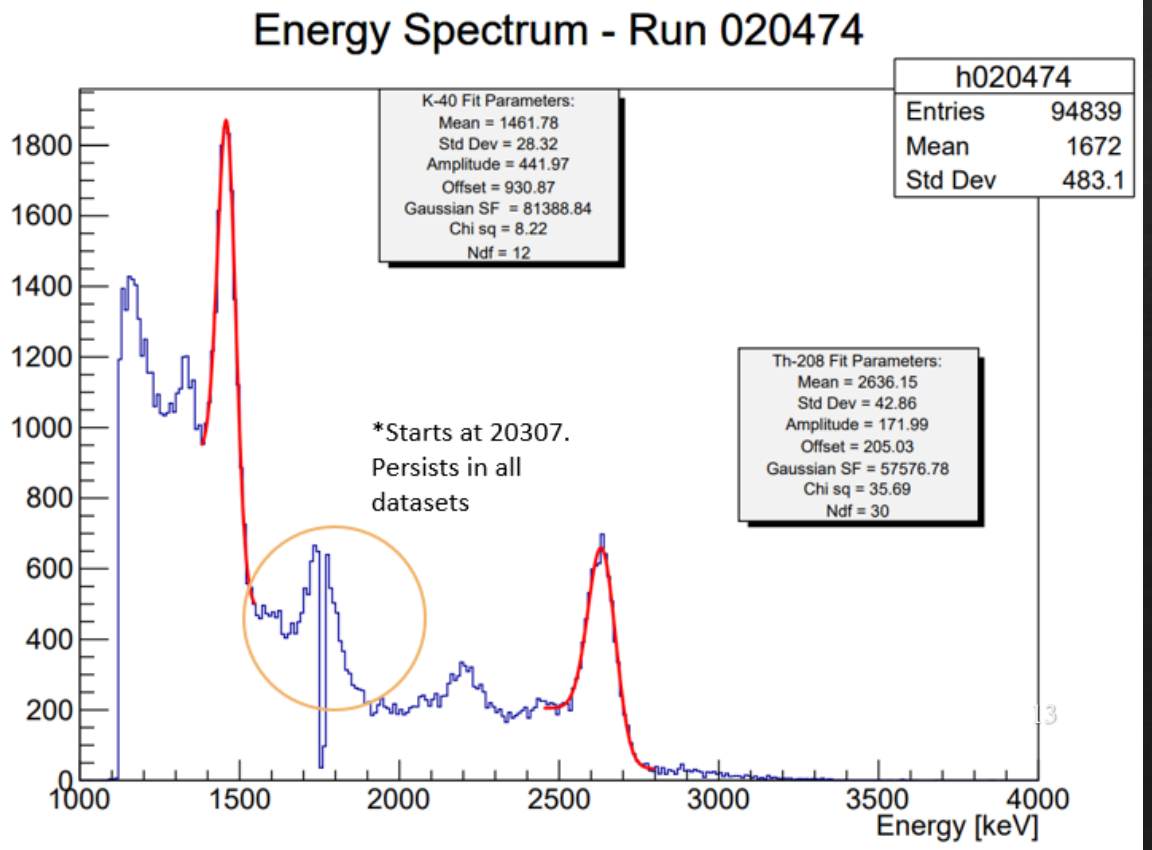


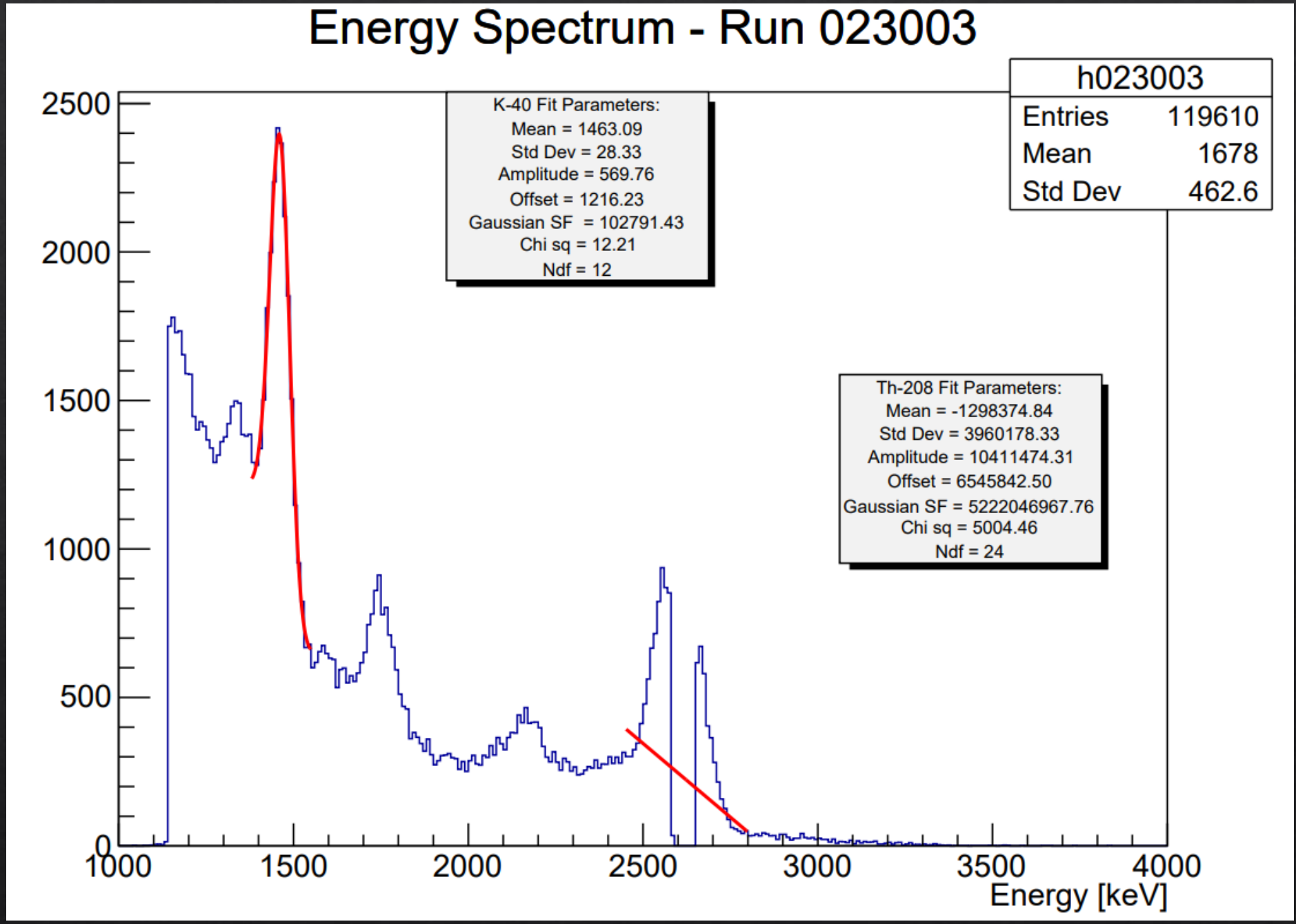


Features to Investigate



PhysicsTrigger_November2016ToDecember2017_L2




Energy Spectrum - Run 023003
h023003
Entries 119610
Mean 1678
Std Dev 462.6
K-40 Fit Parameters:
Mean = 1463.09
Std Dev = 28.33
Amplitude = 569.76
Offset = 1216.23
Gaussian SF = 102791.43
Chi sq = 12.21
Ndf = 12
Th-208 Fit Parameters:
Mean = -1298374.84
Std Dev = 3960178.33
Amplitude = 10411474.31
Offset = 6545842.50
Gaussian SF = 5222046967.76
Chi sq = 5004.46
Ndf = 24
2500
2000
1500
1000
500
0
1000
1500
2000
2500
3000
3500
4000
Energy [keV]

Thank You DEAP and SNOLAB!!